



Climate Action Initiative
BC AGRICULTURE & FOOD

Cariboo Region

BC Agriculture & Climate Change
Regional Adaptation Strategies series

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Cover photograph of hay fields on West Fraser Road,
by Allen Dobb.

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Introduction

In the coming years, climate change will impact the agriculture sector in British Columbia in a range of different ways.

Although agricultural producers are accustomed to adjusting their practices to manage through difficult conditions, the scope and scale of climate change is anticipated to exceed anything previously experienced. Strategies and actions that support and enhance adaptation are the focus of this plan.

In 2011–2012, a province-wide assessment of climate change-related risks and opportunities evaluated the potential impacts of climate change on agricultural production and the sector's capacity to adapt. The assessment made evident that due to British Columbia's diversity (with respect to agriculture, ecology and climate), a regional approach to climate change adaptation is required. Although some adaptation will occur at the farm level, regional and collaborative approaches will be critical for supporting agricultural adaptation.

Building on these findings, in 2012–2013 a pilot project was initiated with agricultural producers, agricultural organizations and local governments in Delta and the Peace River and Cowichan Valley regions. Each planning process resulted in a distinctive set of local sector impacts and priorities, as well as a series of strategies and actions for adapting and strengthening resilience.

The Cariboo plan is the first to be completed beyond the pilot project and with the commitment of funding for implementation through the *Regional Adaptation Enhancement Fund*.¹ The plan is intended to offer clear actions suited to the specifics of the local context, both with respect to anticipated changes and local capacity and assets.

PROJECT DELIVERY

A local Advisory Committee for the Cariboo region was formed to provide input throughout the project. This Committee included participants from the Cariboo Regional District, the BC Ministry of Agriculture and a number of agricultural organizations. The agricultural producer participants volunteered their time throughout the project, representing both local production systems and agricultural organizations. The Cariboo Regional District provided staff time and expertise and covered costs associated with the workshops. With funding from the Growing Forward 2 Program, the BC Agriculture & Food Climate Action Initiative provided core management and human resources for project delivery. Please see Acknowledgements for more details.

PROJECT METHODOLOGY

The development of the Strategies involved three key stages:

1 *Project Development*

Background research was conducted and a project plan was drafted. Two initial meetings were held with the local Advisory Committee to receive input on the project outline and the proposed approach for the first workshop.

2 *Workshops*

Two sets of workshops were held (each set held in two locations — Quesnel and 150 Mile House) for a total of four workshops. The first set of workshops focused on reviewing climate change projections, discussing the associated agricultural impacts and identifying priority impact areas. Developing strategies and actions for adapting to

the priority areas then became the focus of the second set of workshops. Prior to the second set of workshops, a series of overarching goals and strategies was developed and reviewed by the Advisory Committee. These materials provided support for the workshop action planning process (which also incorporated consideration of local priorities, context and resources).

3 *Implementation Meeting*

An implementation meeting was held with approximately 40 participants representing many of the key local partners. The meeting involved prioritization of draft actions based on which were considered most important, easiest to implement and supportive of enhanced capacity for additional adaptation. The meeting also included discussion of steps to implement prioritized actions.



photo by Allen Dobb, cattle range near 150-Mile

Regional Context

The Cariboo Regional District (CRD) extends from near 70 Mile House in the south to just south of Hixon in the north, and from the Cariboo Mountains in the east to the Coast Mountains in the west. The region is 80,262 square kilometres and includes 12 electoral areas and four incorporated member municipalities (100 Mile House, Quesnel, Wells and Williams Lake).² There are also 15 Secwepemc, 'Tsilhqot'in and Carrier communities in the region.³

Much of the Cariboo region is high, rolling plateau (with multiple mountain ranges). The Fraser River winds through the region, where forage crops are produced on the benches of the river and its tributaries. The capability of the soils in much of the region are a limiting factor, but areas with better river bench soils are able to produce high quality forage as well as root vegetables and potatoes. Some valleys soils have high clay content but with careful management, can produce a range of forage and field crops.⁴

With the size of the region and its diverse topography, micro-climates across the Cariboo vary considerably. The climate is generally warm and dry in the summer, and winters are cold with low to moderate precipitation with a range of 250–630 mm annually.⁵ The region lies in the rainshadow of the Coast Mountains and its southwestern portions are driest with precipitation and humidity increasing slightly toward the east and more toward the north. The growing season varies, generally shortening with increased elevation.⁶ The landscape of the Cariboo region is extremely diverse. In the western and relatively dry portion of the region, the Chilcotin Plateau is characterized by Lodgepole Pine stands,

with some occurrence of Douglas-fir and Ponderosa Pine. In the southeast corner of the region, drier conditions support grasslands at lower elevations, with spruce forest in the north. Interior rainforests in the Cariboo Mountains support Engelmann Spruce and sub-alpine fir.⁷

The economy of the Cariboo region is resource-based, with strong agriculture, forestry, mining and tourism sectors. In 2011, 4% of the total labour force in the CRD was employed in agriculture.⁸ Other key industries include wood and paper manufacturing, and a diverse range of energy projects including an emerging bioenergy sector.⁹ The economy of the region has been in the midst of a significant transition over the past decade, largely due to the impacts associated with the Mountain Pine Beetle.¹⁰ The scope of beetle kill in the region has long-term economic and ecological implications. The impacts on forests and rangeland, particularly to hydrology and soils, are of concern to the agriculture sector.

There are more than a thousand farms in the region, totaling over a million acres and accounting for 3% of the provincial agricultural production. Farms range in size from a few acres to more than 3,000 acres.¹¹ The majority of agricultural land is located along Highway 97, following the Fraser River, and along Highway 20 East (which follows the Chilcotin River) to Alexis Creek, which is located 114 km west of Williams Lake.¹²

About 11% of the Cariboo region's overall area is suitable for agriculture with 936,255 hectares included in the Agricultural Land Reserve in 2012.¹³ Moisture deficit during the growing season is a substantial

limiting factor and at present 16,820 hectares in the region are under irrigation, reduced from 19,566 hectares irrigated in 2006.¹⁴

The beef cattle sector makes up about 27% of the agricultural operations in the region (farms where beef cattle contribute more than 50% of the estimated farm income), and forage crops make up 93% of the total cropped area (50,449 hectares).¹⁵ Crown range provides about 40% of the annual forage requirements of the ranching industry. As has been the case across BC, there has been a significant reduction in the numbers of beef cattle in the region since the early 2000s (from 57,015 in 2006 to 39,430 in 2011).¹⁶

There has been growth in the diversity of the sector in recent years. Livestock production includes dairy, sheep and goats, game farming, horses and poultry. There has also been an increase in the number of dairy cows in the region since 2006 (from 184 in 2006 to 1,090 in 2011). 2011 statistics indicate 3,045 hectares of horticultural crops including: field crops, fruits, berries and nuts, vegetables and nursery products. The region is also home to other production systems including Christmas trees and greenhouse operations.¹⁷

The cattle producers in the Cariboo region participate in 11 local organizations which link into three regional associations: Cariboo Cattlemen's Association,

Quesnel Cattlemen's Association and the South Cariboo Cattlemen's Association. Other agricultural organizations such as the farmers' institutes, the Agriculture Enterprise Development Centre and North Cariboo Agricultural Marketing Association (FARMED) tend to be geographically based or focused on offering services to producers within a particular part of the region (e.g., farmers' institutes). Some new initiatives (such as the Agriculture Horticulture Leap) have recently emerged to support producers in the region with improved business development, educational and extension supports.¹⁸

The Cariboo Regional District does not have a formalized agriculture plan, however objectives and policies to support and encourage agriculture are included in a number of the Official Community Plans of local governments of the region. Agriculture is also seen as important in the Economic Diversification Strategy that was the culmination of multi-sectoral planning for the post-beetle era.¹⁹

The Cariboo Regional District is developing a draft Agriculture Policy. The draft policy focuses on the urban/rural interface and intends to assist in promoting compatibility between agricultural and non-agricultural land uses by providing clear policies, tools and techniques, and complementing existing and proposed agricultural policies in Official Community Plans.²⁰

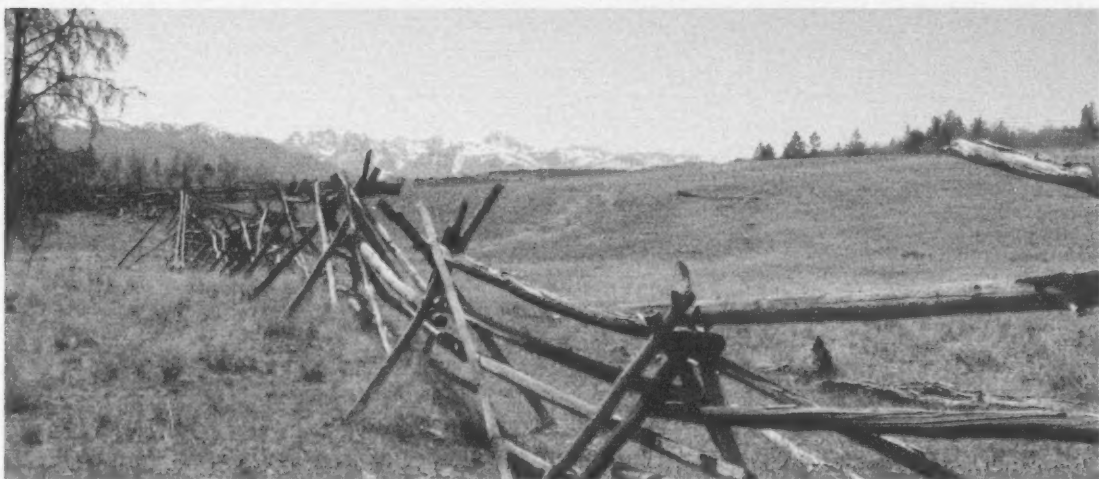


photo by Allen Dobb, range near Choelequoit Lake

Regional Climate Science

Accessing the best possible information about climate change is a first step in determining the options for action. For many years, climate scientists have been improving and refining climate models to produce more accurate future projections. These models have now been validated against observed climate records. The resolution of the data and models continues to increase, enabling the kinds of regional projections that follow.

The Pacific Climate Impacts Consortium (PCIC) is a regional climate service centre at the University of Victoria that provides practical information on the physical impacts of climate variability and change, in support of long-term planning.²¹ PCIC was a key partner in developing the pilot projects that preceded the Cariboo strategy, and has assisted in the production of the agriculturally relevant, regional climate projections for the 2020s and 2050s that are presented.

Additional information about regional climate projections, maps, and related definitions may be found in Appendix B and Appendix C, and in PCIC's Cariboo climate summary at:

http://www.pacificclimate.org/sites/default/files/publications/Climate_Summary-Cariboo.pdf

CARIBOO REGIONAL CLIMATE PROJECTIONS: 2020s TO 2050s

Key climate projections for the Cariboo region in the 2020s to 2050s are summarized here. Projections are derived from PCIC's online tool, "Plan2Adapt." Numbers provided are the median of all model runs

Temperature Projections

- Annual average is 1°C warmer by 2020s (+1.8°C by 2050s)
- 12 more frost-free days annually by 2020s (+23 days by 2050s)
- 147 more growing degree-days annually by 2020s (+280 days by 2050s)

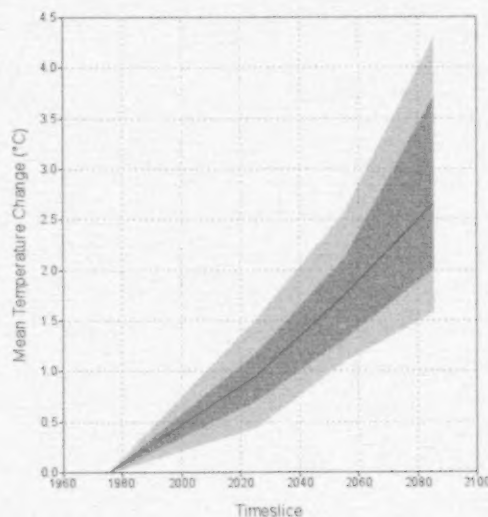


FIGURE 1 Mean Annual Temperature change, 1960s to 2080s

(black line in the graphs), and the shaded area on the graphs shows the range of projected possible future conditions.²²

Temperature

Projections for key temperature variables show a strong increasing trend with all models projecting warming in all seasons (see text box and Figure 1, previous page). This trend is significant compared to historical variability, and summer is projected to warm more than other seasons.

Precipitation

While models show the possibility for both increasing and decreasing future annual precipitation, the median trend is a slight increase.

The majority of models show a decrease in summer precipitation. There may be a slight increase in the amount of winter precipitation, with a slight decrease in the amount falling as snow (see Figure 2).

The distribution of these temperature and precipitation changes are greatly influenced by local geographic settings — temperature by elevation, and precipitation by topography. As Figure 3 shows, temperatures are higher in the central plateau of the Cariboo region, with cooler temperatures and wetter conditions in the mountainous western and eastern perimeters. Agricultural areas are primarily located in the central plateau sections and so therefore would be affected by these temperature increases.

Precipitation Projections

- Annual precipitation: +4% (may increase) by 2020s (+6% by 2050s)
- Summer: +2% (may increase) by 2020s (+3% by 2050s)
- Winter: +4% (may increase) by 2020s (+7% by 2050s)
- Winter Snowfall: -2% decrease by 2020s (-9% by 2050s)

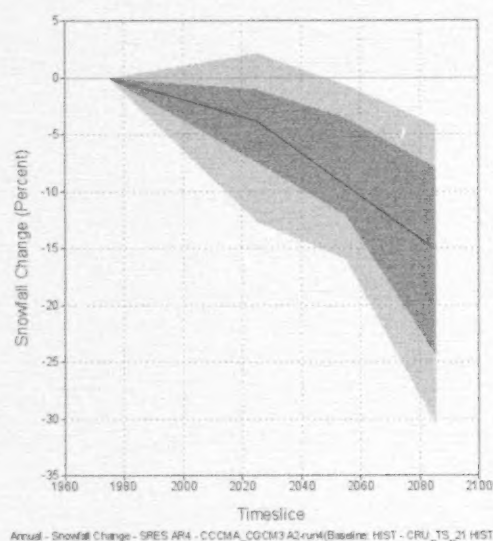


FIGURE 2 Precipitation as Snow, 1960s to 2080s

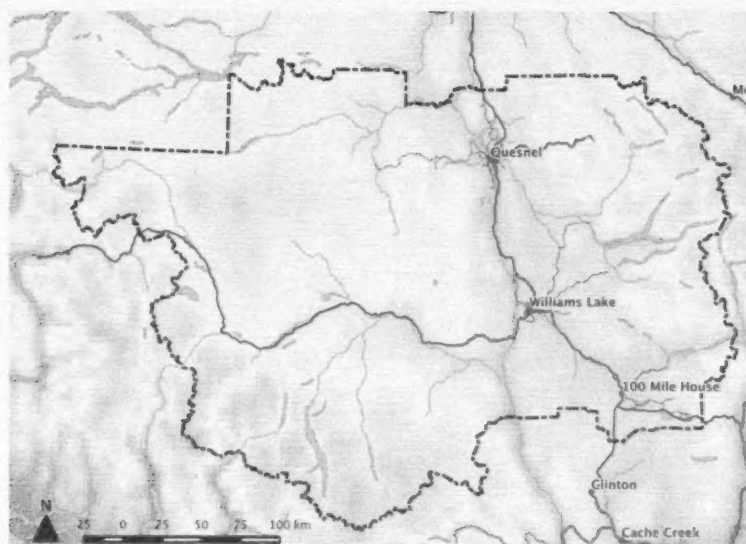


FIGURE 3 Cariboo Region Mean Annual Temperature, 2050s

Map illustrates the cooler mountainous region to the west, and the warmer eastern plateau where most agricultural lands are located.

RELATED EFFECTS

The magnitude, frequency and intensity of extreme events, for both temperature and rainfall, are also forecast to increase with climate change. Extreme cold temperatures may occur less frequently, and unusually warm temperatures more often. The intensity and magnitude of extreme rainfall events may continue to increase. Extreme heat events, coupled with drier summers, contribute to increasing wildfire risk. Detailed projections for 2050s extremes are provided in text box at right.²³

As precipitation in the Cariboo region changes, Fraser River flows may be affected. River systems in the region will likely see a shift to a more rain-dominated pattern, with less predictability and increased variability in timing and volume of flows. With changes to snowpack and temperatures, runoff peaks may occur earlier in the season, with lower discharge later in the summer.

The projected changes outlined in this section will affect the Cariboo's agricultural sector. The ecological effects and resulting agricultural impacts of these projected climate changes are summarized in the next section.

Extremes

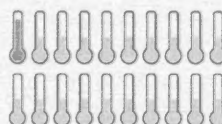


recent past

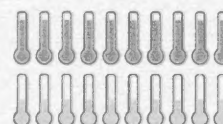


2050s

- 2.5 times the number of summer "warm days" (days in June, July and August that are warmer than the 90th percentile historic baseline temperature for that day)



recent past



2050s

- 10 times the number of extremely hot days (days so hot they used to occur only once every 25 years)
- Increased frequency, intensity and magnitude of extreme rainfall

Agricultural Impacts

The changes in climate projected for the Cariboo region will have a range of impacts on the agriculture sector. These impacts are summarized in the table immediately below.

TABLE 1 Potential impacts of climate change on agricultural production in the Cariboo region

Projected Climate Changes	Effects	Potential Agricultural Impacts
<ul style="list-style-type: none"> Increasing summer temperatures Decreasing summer precipitation 	<ul style="list-style-type: none"> Increasing wildfire risk 	<ul style="list-style-type: none"> Increase in severity and frequency of damages to agricultural infrastructure and productivity Costs of preparing for, managing, and responding to wildfire Psychological impacts Increase in agriculture/ wildlife encounters due to wildlife displacement Smoke and ash negatively affecting livestock/ crop health and productivity Long-term impacts to soil and hydrology after moderate-high severity burns
<ul style="list-style-type: none"> Decreasing summer precipitation Decreasing snowpack (esp. in spring) 	<ul style="list-style-type: none"> Changing hydrological regime <ul style="list-style-type: none"> Decreasing summer & fall water supply Decreasing runoff (esp. in summer) More frequent drought conditions 	<ul style="list-style-type: none"> Decrease in quality and amount of water supply for livestock & irrigation Water stress and decreased productivity for crops and rangeland Increase in need for water storage and irrigation (and associated costs) Increase in potential for overgrazing Increase in feed costs in dry years (when lack of forage)
<ul style="list-style-type: none"> Increasing winter temperatures Increasing extreme rainfall events Shifting precipitation patterns 	<ul style="list-style-type: none"> Changing hydrological regime <ul style="list-style-type: none"> More frequent rain on snow events Increasing flooding and runoff 	<ul style="list-style-type: none"> Increase in damage to infrastructure and productivity Increase in soil erosion Risks to dam integrity Increase in challenges with input and nutrient management Challenges with timing for planting and harvesting

table continued on next page →

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Project 1 Climate Changes	Effects	Potential Agricultural Impacts
<ul style="list-style-type: none"> Increasing variability of conditions and extremes 	<ul style="list-style-type: none"> Increasing variability of conditions 	<ul style="list-style-type: none"> Interruption or damage during planting, germination and harvesting Overall increase in management complexity and costs Acceleration of cumulative impacts Negative affects to livestock health/immune systems Increase in hazardous winter conditions for livestock (freeze/thaw cycles etc.) Uncertainty in length of grazing and/or feeding periods
<ul style="list-style-type: none"> Increasing temperatures 	<ul style="list-style-type: none"> Increasing growing degree days/heat units 	<p>Challenging agricultural impacts:</p> <ul style="list-style-type: none"> Impacts to agricultural viability in some areas Decreased suitability of some crops <p>Potential opportunities:</p> <ul style="list-style-type: none"> Increase in suitability for new varieties Increase in suitability of new crops Opportunity for season extension and additional cropping
<ul style="list-style-type: none"> Increasing winter temperature and seasonal temperatures Increasing spring precipitation and extreme rain events Drier summer conditions 	<ul style="list-style-type: none"> Changing pests, diseases, invasive species and pollinators <ul style="list-style-type: none"> Increasing winter survival rates Increasing number of cycles in a year Introduction of new pests and diseases 	<ul style="list-style-type: none"> Increase in crop damage and losses Increase in management costs, complexity, uncertainty Negative effects on livestock health Reduction in pollinator populations or shifts in pollination timing
<ul style="list-style-type: none"> Climate change in other growing regions 	<ul style="list-style-type: none"> Variability of global agricultural production 	<p>Challenging agricultural impacts:</p> <ul style="list-style-type: none"> Increase in feed or other input costs Fluctuation in input prices will cause more challenges to planning <p>Potential opportunities:</p> <ul style="list-style-type: none"> Increase in demand and prices for food production/local food Potential competitive advantage in changing global markets Increase in farming diversity in the region (filling gaps in market)
<ul style="list-style-type: none"> Increasing temperatures Shifting precipitation patterns Increasing wildfire frequency and severity 	<ul style="list-style-type: none"> Changes to wildlife and ecological systems 	<ul style="list-style-type: none"> Changing patterns of plant succession and species composition due to extremes, fire events etc. Loss of crops, livestock, forage and stored feed (and associated costs) Establishment of new invasive plants

The set of "impact areas" identified in Table 1 (groupings of projected climate changes and their associated effects and agricultural impacts) formed the basis for discussions at the first set of workshops. These impact areas were explored in detail with participants, and ranked in order of importance for both the individual farm and regional level. Based on this input, the highest priorities were identified and some impact areas in the table above were excluded from consideration at the second workshops. Adaptation strategies may still be needed to address the excluded impact areas in the future.



photo by Allen Dobb, raspberries and blueberries in North Cariboo

Priority Impact Areas, Strategies & Actions

The following five impact areas were identified as the highest priorities with respect to agricultural adaptation in the Cariboo region:

- **IMPACT AREA 1**
Increasing wildfire risk
- **IMPACT AREA 2**
Changing hydrology
- **IMPACT AREA 3**
Increased variability
- **IMPACT AREA 4**
Changing pests, diseases & invasive plants
- **IMPACT AREA 5**
Changing wildlife & ecological systems

For each of the priority impact areas, a background description and adaptation goals are included. Strategies and actions to support the Cariboo region

agriculture sector with adapting to climate change follow the impact descriptions.

The strategies and actions presented were developed to:

- Address the highest priority impact areas;
- Reduce vulnerability to these impacts, and/or build capacity to adapt and respond to these impacts; and
- Define practical steps forward that address gaps and build on existing resources in the Cariboo region context.

Following the strategies and actions, the final section of this plan highlights those actions identified for near-term implementation. Implementation details, key participants, timeframes and cost ranges are provided for these near-term priority actions.



photo by Allen Dobb, Williams Lake area

IMPACT AREA 1

Increasing wildfire risk

THE CARIBOO REGION has experienced several significant wildfire seasons in recent years including 2009, 2010 and 2012. With projections for more prolonged warm and dry periods, as well as more extremely hot days, it is anticipated that the number and severity of wildfires will increase in the future. Wildfires jeopardize agricultural production capacity including livestock, range and crop health and agricultural infrastructure.

Preparing for and managing through wildfires involves financial, emotional and psychological cost. Wildfire impacts on agriculture go beyond those areas immediately in harms way, as more widespread smoke and ash can also negatively affect the health and productivity of livestock and crops. Wildfires also displace wildlife, increasing agriculture and wildlife interactions in adjacent areas.

Some longer lasting agricultural impacts of wildfire include changes to soil characteristics and species composition where intensive burns have occurred. Flooding, soil erosion and land slide risk may also increase in burned or adjacent areas.

Currently, the limited fire mitigation resources are primarily focused on the community/wildfire interface, but many of the Cariboo's agricultural operations exist outside of this area. Therefore, there would be value in developing approaches that are tailored to the context of agricultural operations, specifically to improve informational resources and engagement with the sector for wildfire preparedness, mitigation and recovery planning.

Relevant Climate Change Effects

- Increasing summer temperatures and decreasing summer precipitation
- Increasing extreme hot temperatures
- Increasing dry conditions
- Increasing variability of conditions

The strategies in this section work toward the goal of:

- *Minimizing the damage to agricultural productivity and assets associated with wildfire events.*

IMPACT AREA 1 > STRATEGY 1.1

Collaborative approaches to fuel management & wildfire mitigation

NUMEROUS PARTNERS, PLANS and levels of government are involved in fire prevention and management in the Cariboo region, including local fire departments, Regional Emergency and Protective Services and the Cariboo Fire Centre (part of the provincial government Wildfire Management Branch).

Despite planning for the local, regional and provincial levels, wildfire management plans do not specifically address the agriculture/wildfire interface.²⁴ For example, the *Cariboo Regional District Community Wildfire Protection Plan* includes recommendations about fuel thinning and interface risk reduction, but fuel management is focused on the urban interface, and more densely populated areas are first priority for fuel reduction treatments.²⁵

With respect to fire management, variable terrain and transportation issues (such as the lack of access between the east and west sides of the Fraser River in some places) increase the challenges associated with firefighting and fuel reduction. Improved collaboration with the agricultural community, in planning for and mitigating wildfire, would benefit the sector and strengthen the information and resources available in emergency situations. In many cases, producers know the local terrain and available water sources better than anyone else. For these reasons, the actions in this strategy focus on bringing agricultural issues to the forefront and strengthening the relationships between emergency managers, responders and the agriculture sector.

ACTION 1.1A Develop collaborative agriculture wildfire plans

- Identifying appropriate agriculture planning areas
- Developing a planning template and piloting collaborative agriculture wildfire plans in 3-4 areas
- Exploring options to integrate agriculture plans into Landscape Fire Management Planning
- Determining mechanisms to keep plans updated and current
- Planning could include:
 - Identification of natural firebreaks and plans for establishing and maintaining them
 - Identification of fuel management priorities and suggested fuel management treatments
 - Inventory (and availability) of water sources
 - Locations of access routes and local trails
 - Identification of local agricultural contacts/ liaisons who will serve as community liaisons and VECs (volunteer emergency contacts)

ACTION 1.1B Develop collaborative fuel-management strategies for high-risk agricultural interface areas

- Identifying high-risk interface areas and sector priorities and management options including:
 - Review of prescribed fire certification process in other jurisdictions (examples exist in the US)
 - Explore permitting process allowing ranchers to manage fuel on Crown land (e.g., resurrect or change the small-scale salvage program as a part of the new landscape level management strategy)
 - Explore linkage to biofuel tenures and industry
- Convening key partners (Ministry of Forests, Lands and Natural Resource Operations, forestry companies etc.) to discuss options for removal of forest fuels near agricultural operations
- Seeking opportunities for funding and implementation support

IMPACT AREA 1 > STRATEGY 1.2

Farm-level wildfire damage mitigation planning

THE AGRICULTURE SECTOR and individual producers can develop and implement plans to assist in mitigating wildfire damage to agricultural assets. Agriculture-specific resources and training are required to facilitate this process.

Other fire-prone jurisdictions (such as Alberta) have developed informational materials and/or manuals designed to assist producers to effectively reduce and manage wildfire impacts on-farm; these materials could be adapted to the BC context. Some of the suggested approaches in these resources include: planning and communication among neighbouring producers, firebreaks, water storage for firefighting, evacuation planning, and combustibles management. A pilot farm-level or sector-level approach to using these resources would help to identify costs, issues and barriers around implementation of mitigation measures.

The BC cattle industry has recently undertaken an “all hazard” planning process with the BC Ministry of Agriculture, which may support or link with individual producer wildfire mitigation planning. Individual farm plans can also connect with collaborative planning (as per Strategy 1.1) and provincial wildfire preparedness and mitigation efforts.

ACTION 1.2A Develop agriculture specific wildfire preparedness and mitigation resources

- Reviewing existing written materials (within BC and beyond), identifying transferable resources and practices and identifying information gaps
- Developing a BC farm and ranch specific manual for fire preparedness, mitigation and recovery
- Hosting an agriculture-specific Fire Smart workshop in the Cariboo
- Facilitating on-going agriculture sector access to Fire Smart planning

ACTION 1.2B Develop individual farm/ranch-level wildfire plans (fuel management/asset protection etc.)

- Supporting development of individual farm/ranch wildfire plans (utilizing resources developed through action 1.2a)
- Assisting producers to identify and implement fuel management strategies on their own properties (e.g., facilitating linkages between producers and forest licensees to enable logging near agricultural/ Crown land interface)
- Refining farm-level planning process and seeking mechanism for broad uptake

ACTION 1.2C Increase access to basic fire education and training for producers

- Increasing opportunities for producers to participate in Fire Smart education
- Working with colleges or other partners to ensure S-100 (Basic Fire Suppression and Safety training) is offered at times and locations accessible for producers

IMPACT AREA 2

Changing Hydrology

RISING TEMPERATURES AND decreasing summer precipitation, combined with earlier peak flows mean that dry periods in summer are projected to increase and intensify, while growing days are becoming longer and warmer. This means that in the future agricultural water demand is likely to increase at times when water supplies are at their lowest levels.

Depending on location and production systems, both water storage (most frequently via storage reservoirs) and irrigation are utilized in the Cariboo region. There are about 354 active dams (not all agricultural) and approximately 2,500 agricultural water licenses in the region.²⁶ Irrigation systems vary, and include overhead systems, flood irrigation, drip irrigation and innovative approaches such as pod irrigation systems. Some producers in the region irrigate directly from the Fraser River and its tributaries; others utilize groundwater or rely on various surface water sources.

For producers in the Cariboo region, continued access to sufficient water for irrigation and livestock watering is a significant concern. A focus on healthy water systems and water supply, as well as continuous improvement in agricultural water management practices, will enable agricultural production in the region into the future.

Along with more prolonged hot and dry periods, projections also show an increasing amount of precipitation in the winter and spring, and an increase in extreme precipitation events. This is likely to contribute to flooding, runoff and erosion impacts (e.g., damage to infrastructure, crop losses, increased costs and challenges due to road washouts).

In recent years, there has been both spring (freshet) and autumn flooding in some parts of the Cariboo. The Anahim Lake area experienced both types of flooding in the 2010/2011 period. Many more

Relevant Climate Change Effects

- Increasing summer temperatures and decreasing summer precipitation
- Increasing extreme hot temperatures
- Increasing dry conditions
- Increasing winter temperatures
- Increasing extreme rainfall events (intensity and frequency)
- Shifting precipitation patterns (increasing rain in winter and spring, rain on snow)

areas are vulnerable to impacts associated with flash flooding and increased runoff across the agricultural land base. With climate change, the conditions that cause flooding, runoff and associated erosion are anticipated to increase in frequency and intensity.

In the near-term, the areas most impacted by the removal of beetle kill timber or wildfires are likely to experience more acute runoff issues. Erosion associated with runoff causes loss of soil and nutrients and (depending on season) crop loss may occur.

The strategies and actions in this section address the following *adaptation goals*:

- *Ensuring sufficient availability of sustainable water supply for agricultural production*
- *Minimizing damage and losses associated with flooding, runoff and erosion*

IMPACT AREA 2 > STRATEGY 2.1

Restore & enhance natural water storage capacities in local watersheds

ENHANCING WATER STORAGE capacity is one means of reducing vulnerability associated with extended dry periods and warmer temperatures. Water quantity and storage have been identified as a significant issue in broader watershed initiatives within the region.²⁷

In some areas of the Cariboo, the water retention capacity of the land base has been impacted by loss of tree cover (and subsequent runoff/erosion). Restoring and managing watersheds sustainably is a critical element of stabilizing and retaining future water supply. Healthy riparian areas assist in holding water and regulating runoff, flooding and groundwater recharge. Storage that integrates watershed and riparian function will create “co-benefits” (e.g., riparian habitat or improved water quality) that interest other partners while supporting agricultural objectives to retain water supply.

ACTION 2.1A Establish local watershed restoration projects to evaluate and demonstrate restoration and enhancement options

- Focusing on agriculture's priority water issues to define project and planning area parameters (e.g., areas with potential for water scarcity)
- Identifying small-scale and manageable local projects
- Including multiple producers/landowners in the same project
- Securing multi-year, stable funding (to enable meaningful data collection and results)
- Building interest and relationships for broader watershed planning

ACTION 2.1B Evaluate, demonstrate and share soil management and cropping options for improved water retention

- Identifying scale and location for trials/demonstration projects
- Hosting a “meet the researchers/producers” day (to align research with needs)
- Building on the soil carbon studies conducted to date (Thompson Rivers University) to determine value of soil improvements including:
 - Incorporating monitoring and data on water holding capacity/soil organic matter relationships
 - Incorporating cost/benefit analysis and data on economic benefits
- Identifying potential for locally sourced soil amendments
- Supporting knowledge transfer for best practices

AS NOTED EARLIER, there are a number of small agricultural dams in the Cariboo region. These dams are subject to changes in the BC Dam Safety Regulations (made in November 2011).²⁸ Although dams (and water storage) have value to a range of stakeholders, agricultural producers that are considered dam owners are often solely responsible for mandatory engineering assessments, upgrades, maintenance and management.

This raises the concern that because assessments, upgrades and maintenance are costly, some producers are opting to decommission dams rather than maintain them. Yet water storage will be increasingly critical for agriculture in the years ahead. Seeking out collaborative options for maintaining agriculturally significant dams into the future is the primary focus of the activities below.

**ACTION 2.2A Inventory and prioritize existing dams/
water storage**

- Undertaking an industry-led inventory process in order to:
 - Determine current status of agricultural dams and water storage (build on Ministry of Environment information re: registered dams)
 - Identify areas of need, issues with existing dams and potential for increased storage
 - Determine which sources have leases on them that may not be renewed; seek opportunities to maintain supply for agriculture

**ACTION 2.2B Develop cooperative approaches to dam
assessments, upgrades, maintenance and management**

- Identifying, clearly defining and documenting co-benefits associated with dams and their maintenance/upgrades (e.g., potential for riparian/wetland enhancement)
- Defining potential cost and risk-sharing strategy with key partners (forestry, fisheries, environment) for dam management, maintenance and upgrades
- Identifying cooperative projects to pilot shared responsibility approach

CLIMATE CHANGE WILL contribute to increased demand for, and reduced supply of, water for irrigation and livestock when it is most needed. Depending upon their crops and location, some producers in the Cariboo utilize irrigation regularly to maintain productivity. Others, due to their location and/or lack of access to water sources, do not have irrigation. As noted earlier, a range of irrigation systems and practices are used in the region. This varying set of circumstances also requires a range of potential adaptation measures including maximizing irrigation efficiency and identifying best production practices and crops for areas without irrigation.

Increasing awareness and application of existing management tools will help producers to improve irrigation management. Foremost among these tools are the irrigation calculator and irrigation manuals available on-line.²⁹ Irrigation assessments are an important preliminary step to ensure that systems are well designed for efficiency. Equally important is testing, demonstrating and refining technologies and production practices suitable to the Cariboo context.

ACTION 2.3A Promote irrigation assessments and disseminate existing irrigation and water management tools through locally effective means

- Increasing awareness of the availability and value of existing tools through appropriate communication mechanisms (e-newsletters, direct mail-outs/emails, producer meetings)
- Offering workshops to share the irrigation calculator and manuals and assist producers with their application
- Promoting irrigation assessments and the use of the Environmental Farm Plan Program to strengthen irrigation systems and practices

ACTION 2.3B Demonstrate and evaluate innovative irrigation technologies and water management practices within the Cariboo's agricultural context

- Identifying technologies and/or practices with the most promise for Cariboo (from BC and beyond)
- Including best practices for dryland agriculture, as well as irrigation and water management
- Identifying producer cooperators for project participation
- Developing demonstration projects and sharing results through:
 - Field days or tours
 - Detailed written summaries of data collected
 - Producer meetings

IMPACT AREA 2 > STRATEGY 2.4

Identify flood & runoff prone agricultural areas & implement mitigation measures

AS NOTED EARLIER, areas along the Highway 20 corridor experienced flooding in 2010 and portions of the Cariboo were on alert for freshet-related and flash flood risk in 2011 and 2012. With increasing variability, changes to local snow melt as well as freshet melt timing and intensity are likely to increase flood risk in parts of the Cariboo. Climate change is anticipated to lead to a slight overall increase in annual precipitation but more of this precipitation will fall during individual (extreme) events, resulting in increased runoff, flooding and erosion.

Impacts associated with runoff are particularly challenging in those areas of the Cariboo that have had significant pine beetle-related timber removal. Identifying the agricultural areas most vulnerable to runoff and flooding impacts and evaluating causes and potential solutions is a first step. Improving the natural water retention capacity of soils and riparian areas will assist in reducing runoff and flooding, but will require collaborative approaches to management and infrastructure. In addition to working cooperatively, individual producers may need to implement practices or invest in infrastructure that will help to minimize negative impacts to production areas and farm assets.

ACTION 2.4A Inventory agricultural areas vulnerable to flooding and significant runoff/erosion impacts

- Consulting with producers and local experts to identify areas impacted by flooding and runoff (and likely to be impacted in the future)
- Documenting details regarding flooding events (watershed activities and impacts etc.)
- Analyzing and mapping agricultural flood and runoff risk areas

ACTION 2.4B Identify, pilot and evaluate low-cost flood mitigation infrastructure options (e.g., spillways into storage, riparian management, berms, embankments etc.)

- Conducting background research to identify suitable infrastructure options (those already used locally or in other jurisdictions)
- Analyzing potential for local adoption of various infrastructure options (i.e. "ground-truth" with producers and other specialists)
- Identifying potential cooperators and sites for piloting
- Developing projects to pilot approaches and ensuring monitoring, documentation and sharing of results (monitoring needed over long-term)

ACTION 2.4C Pilot joint management projects for enhancing natural water retention capacity across the region to minimize runoff (e.g., build soil organic matter, restore riparian areas)

Please see Actions 2.1a for and 2.1b for details.

IMPACT AREA 3

Increasing Variability

IN RANKING THE risks associated with climate change, workshop participants identified increasing variability in conditions as one of the most significant challenges. Uncertainty in the timing, extent and frequency of variable and extreme conditions, makes it difficult to plan for particular conditions. It requires that producers seek to maximize their ability to respond to a broad range of projected changes.

Projections for more variability in conditions across the seasons will increase the complexity of management for agriculture. Critical windows in the production season (such as planting and harvesting) may also be less predictable. Variability in winter conditions is of particular concern for livestock producers, due to factors such as storm events, extreme temperatures and freeze/thaw cycles. Crops and livestock will require resilience to a greater range of conditions. Parameters for crop suitability may shift in some areas reducing the viability of some crops and increasing the potential of others.

A pivotal strategy for adaptation is implementing technologies, practices and production systems that enable producers to manage through a range of potential conditions. This also means evaluating existing practices in a more integrated way — within farming systems and their specific environments — and how climate change may influence management decisions.

The strategies and actions in this section address the following *adaptation goal*:

- *Strengthening the capacity of agricultural operations to manage through variable conditions*

Relevant Climate Change Impacts

- Increasing variability
- Increased precipitation in spring
- Increased extreme rainfall events
- Increasing temperatures
- Increasingly dry conditions
- Increasing growing degree days

CARIBOO PRODUCERS ARE familiar with adapting to changing conditions. Adjusting existing practices and exploring alternative practices may bolster resilience but requires piloting, evaluation and demonstration in the Cariboo context. With a changing climate, different crops and crop varieties may be more resilient or suitable for projected conditions.

The Cariboo region is very diverse with respect to elevation, terrain and growing conditions; the north and south of the region are quite distinct and many more localized distinctions exist. It is difficult (but important) for local research to take into account the range of conditions that producers are working within. A number of research projects have been undertaken in the Cariboo in recent years including forage variety trials and a silvopasture trial.³⁰ This research provides good work (and relationships) to build on for adaptation-focused activity.

It is a common challenge — largely due to limited funding and associated timeframes — that agricultural research projects do not always collect the data that is most valued by producers (such as details about weather, soils and economics). This can make it difficult for producers to know whether practices or varieties under evaluation are suitable for their circumstances and is an important element to include in future local research. The importance of *effective* sharing of research results and knowledge transfer is also a high priority for local adaptation research.

ACTION 3.1A Strengthen the capacity for a coordinated regional approach to agricultural research

- Unifying and sharing existing Cariboo-focused information and research by:
 - Inventorying and compiling research to date (and current activities of post-secondary institutions)
 - Improving accessibility of findings from previous research
- Developing a regional research alliance or organization that would:
 - Engage a broad range of agriculture producers (membership based)
 - Provide a regional hub/umbrella for agricultural research to prioritize and track research and assist with securing and distributing funding
 - Develop regionally focused resources materials (e.g., soils data)
 - Communicate and share research or relevant work – newsletters, quarterly reports, materials specifically for producer interests

ACTION 3.1B Undertake applied research of management practices to enhance resilience in variable and changing conditions

Ideas for priority areas include:

- Tillage practices – type and amount of soil disturbance (conservation and minimum tillage approaches)
- Best crops for adding soil nutrients and organic matter (for improving soil biodiversity and function)
- Pasture cropping and no-kill – inter-seeding annuals into perennial pasture and seeding without eliminating existing crops
- Approaches for increasing productivity of lands not under irrigation
- Trials/production approaches for managing land without irrigation
- Forage management – looking at species and varieties that work with no or low inputs (managing without pesticides/herbicides)
- Piloting/monitoring approaches for management of invasive plants

continued on next page →

ACTION 3.1C Undertake local variety /new crop trials to assess suitability for variable and changing conditions

- Developing a coordinated and cross-regional approach to trials (Action 3.1a)
- Coordinating producers already trying new things – monitoring and documenting (provide some support/incentive for producers)
- Covering a range of production conditions in the region
- Incorporating the full range of production issues (i.e. more than just seeding/production – also economics, scale of production, harvest, storage)
- Creating informational resource identifying which crops could do well in the region

ACTION 3.1D Increase availability of local education and tools to support producers in managing variable conditions

- Supporting existing/emerging post secondary initiatives and encouraging a direct relationship to producer priorities (Thompson Rivers University and University of Northern BC)
- Increasing availability of local training and education – workshops, field days, direct and applied information transfer
- Addressing regional diversity through sub-regional approach (i.e. delivering the same information in sessions across the region)

IMPACT AREA 3 > STRATEGY 3.2

Support and enhance holistic and adaptive grazing management systems

ADAPTIVE AND HOLISTIC grazing systems are an important element of enhancing resilience to variability. Some producers in the Cariboo have been refining grazing systems within their specific environments for many years. Along with the challenge of extended dry periods in summer, producers are experiencing increasing unpredictability in winters and shoulder seasons. This includes storm events, extreme temperatures and freeze/thaw cycles. Supporting and enhancing holistic and adaptive grazing systems — specifically by monitoring, documenting and improving available informational resources — will strengthen the ability of Cariboo livestock operations to manage through this kind of variability.

ACTION 3.2A Monitor and evaluate how different grazing and management regimes affect: soils development, nutrient cycling and profitability

- Identifying producer cooperators and monitoring and documenting:
 - Location-specific soil development and nutrient cycling processes under different grazing regimes;
 - Management factors that increase profitability in various local grazing systems (and linkages to ecosystem processes and specific grazing resources)
 - Cost-benefit of different winter feeding strategies (incorporate diversity of conditions, areas, elevations)
- Sharing results of monitoring through accessible knowledge transfer approaches (field days, written summaries etc.)

ACTION 3.2B Expand producer opportunities for education, knowledge acquisition and mentorship for adaptive grazing management

- Bringing experts from other places to the Cariboo to speak/share information (producers often have to travel to access information)
- Adapting and refining existing monitoring and record-keeping tools (for monitoring impacts of management changes) from other jurisdictions and providing training to use tools
- Offering a regular "field school" – field days for producers
- Providing continuing education opportunities for producers that want to keep learning and trying new things (outside the box and focused on profitability)

IMPACT AREA 4

Changing pests, diseases & invasive species

AS TEMPERATURES WARM, particularly winter temperatures, the range and prevalence of pests, diseases and invasive species is anticipated to shift. These changes may involve conditions that enable existing problem species to increase and new species to move into the region.

The Cariboo region has been significantly impacted by Mountain Pine Beetle outbreaks, in part because of a lack of extremely cold winter temperatures to control beetle populations. Some existing pests that producers are concerned may become more problematic include: wasps (for apiculture), fire ants, mildews, root maggots, cutworms, blights, wilts, and the grey tortrix moth in alfalfa. More challenging from the perspective of producers is the potential for the introduction of species into areas where they have not previously existed.

Critical to managing changes in populations and ranges of economically significant species (those that cause extensive damage to crops or harm to livestock) is monitoring what is occurring on the ground. Existing resources around monitoring and management in the Cariboo region include the Cariboo Chilcotin Coast Invasive Plant Committee (CCCIPC), and the Cariboo Regional District's Invasive Plants Program.³¹ The CCCIPC has conducted a number of monitoring and management pilots that provide a strong base for future programs.

The strategies in this section work toward the goal of:

- *Minimizing and managing agricultural impacts of changing pest, diseases, and invasive species distribution and prevalence*

Relevant Climate Change Impacts

- Increasing temperatures, growing degree-days/heat units, growing season length
- Warmer winter temperatures
- Increasing spring precipitation and extreme rain events
- Drier summer conditions

MONITORING ACTIVITY HAS been part of the work of a number of groups in the Cariboo region in recent years. Invasive plants have been the focus of much of this monitoring (such as the work of the CCCIPC). Expansion of these programs and more monitoring is needed for other invasive species, pests and diseases. Distributed monitoring that involves a range of sectors would reduce the pressure on individual organizations and make use of partners already working on the land base. To facilitate this kind of approach, an enhanced community education program is necessary to increase awareness of invasive species, pests and diseases among the general population.

ACTION 4.1A Pilot a community education and monitoring program

- Identifying existing resources and gaps in community education
- Including information on pests, diseases and invasive species in this program, and targeting "non-traditional" groups outside of agriculture
- Developing appropriate engagement/communications tools and disseminating information

ACTION 4.1B Partner with interested agencies to increase local monitoring

- Identifying existing resources and gaps related to monitoring
- Developing partnerships with interested agencies /groups
- Developing tools for identifying, reporting and tracking invasive species (e.g., signage, websites, apps)
- Targeting areas currently under management agreements (Similar to "Adopt-A-Highway" Program)

MONITORING IS AN important first step for an integrated approach to managing emerging pests, diseases and invasive species. However, producers also need to manage their operations to minimize impacts to the health and productivity of livestock and crops. New or changing disease, invasive plant and pest issues will likely require new management strategies.

The Cariboo Cattlemen, Cariboo Regional District, and the CCCIPC have all been involved in supporting education on management practices. For example, a pilot project “Cows Eat Weeds,” involving a small number of cattle producers was successful and well received and there is opportunity to expand and build on this initial work.³²

Evaluating management options that are new or not commonly adopted and providing information on best practices will support producers with effective and sustainable approaches. Examples include: improved soil management, integrated pest management, alternative crop rotations and post-disturbance monitoring (e.g., forestry and wildfire sites).

There may be options to partner with broader provincial initiatives or to develop relatively low cost updated informational resources for agriculture (that could be based on transferable materials from other jurisdictions). As with monitoring, cooperative and community approaches are required to check the spread of pests and invasive species. Continuing to work with other partners and to find local solutions is critical to effective management.

ACTION 4.2A Develop and distribute best practices resources for management of pests, diseases and invasive species

- Identifying pests, diseases and invasive species of greatest concern for agriculture
- Reviewing best management practices (local and transferable from other jurisdictions)
- Recognizing and rewarding local leaders in innovative practices
- Developing communications materials (manuals, workshops, mobile apps)
- Distributing information to producers

ACTION 4.2B Conduct pilot projects for effective farm-level management of pests, diseases and invasive species (particularly for emerging issues)

- Through review process conducted in 4.2a, identifying suitable pilot options
- Identifying producer cooperators and locations
- Conducting pilot projects (in areas with high exposure)
- Expanding communication and implementation of “Cows Eat Weeds” pilot project -include other livestock such as goats and sheep

ACTION 4.2C Collaborate with key agencies and partners for management of pests, diseases and invasive species

- Promoting and building on the work of key groups working across sectors and with the public: CCCIPC, CRD, BC Invasive Species Council
- Assisting in expanding the educational materials to key user groups of the local land base
- Exploring options to integrate invasive species into EFP Program and develop group EFP around invasive species management

IMPACT AREA 5

Changes to wildlife & ecological systems

CHANGES IN CLIMATE are already resulting in documented shifts in ecological systems and the habitats and ranges of particular species. The changes occurring, and projected to occur, in the Cariboo will continue to affect the ecological communities that make up forests and rangelands. The changing climate will affect soils, litter, biomass, growth rates, nutrient cycling and species composition.

As a general rule, climate change will cause the ranges of species to move northward and upward in elevation. The forest-grassland interface is dynamic and will be influenced by climate change, but is also influenced by other natural and human factors.³³ There are likely to be increased invasive weeds and a variable forage supply on the range. In light of these changes, maintaining and/or enhancing range productivity is the focus of Strategy 5.1.

Changing temperatures, precipitation patterns and increased frequency of extreme events will also influence the size, distribution and behaviour of wildlife populations. Further complicating these shifts are the many other factors influencing ecosystems and wildlife (particularly industrial, development and management). In recent years, agricultural producers in the Cariboo region have reported that increasing contact with populations of elk, deer, cranes and wolves is resulting in losses of livestock, crops and feed supplies.

Elk in particular have been noted in areas where they were not present before. Not only are agriculture's interactions with wildlife increasing, but encounters are also occurring outside of typical seasonal timeframes for these encounters. Identifying cooperative approaches to reduce negative wildlife impacts on agricultural production will build on work already undertaken by the Cariboo-Chilcotin Regional Agriculture-Wildlife Committee.³⁴

Relevant Climate Change Impacts

- Increasing summer temperatures and decreasing summer precipitation
- Increasing wildfire frequency and severity
- Increasing extreme rainfall events
- Increasing temperatures and growing degree days
- Shifting precipitation patterns

The strategies in this section work toward the goal of:

- *Minimizing negative wildlife/agriculture interactions (specifically those resulting in agricultural losses)*

SOME BC-BASED RESEARCH on the impacts of climate change on forests and rangelands has been completed but this work has been limited and not focused specifically on the Cariboo region. There is potential to build on this previous work locally through research, monitoring and piloting of innovative range management practices. Changes in climate will lead to shifts in vegetation composition and ecosystems, influencing the productivity of range areas.

More local monitoring is required to better understand the changes taking place and, to be effective, this activity requires collaboration and on-going commitment and investment. Working with other partners, the agriculture sector could explore options to effectively manage for productive rangeland in a changing climate. These options might include: managing grazing to facilitate enhanced grassland plant community response to climate change, building organic matter and water retention capacity of the soil, evaluating management options such as silvopasture, monitoring range to track changes, and piloting alternative livestock watering options.³⁵

ACTION 5.1A Research, pilot and demonstrate practices and technologies for maintaining and enhancing range productivity

- Scanning and summarizing research conducted to date and consulting with partners who led this research to determine gaps and possible next steps
- Identifying agricultural research priorities, opportunities to build on previous research, co-benefits/possible partners
- Undertaking applied field research

ACTION 5.1C Pilot alternative livestock watering options

- Identifying range livestock watering options including innovative options from other jurisdictions (e.g., building water storage and controlling access, portable and other off-site waterers, development of alternative water sources)
- Undertaking a pilot to evaluate costs/benefits of various options with producer cooperators
- Sharing findings through producer meetings, written summaries etc.

ACTION 5.1B Seek partners interested in collaborative monitoring of local rangeland to track changes

- Identifying any existing local monitoring of rangeland
- Identifying various options for monitoring and data analysis (e.g., producer monitoring, summer students, forestry partners etc.)
- Convening partners involved as well as potential new partners
- Ensuring mechanisms for maintaining collaboration and evaluating progress and gaps/issues over time

ACTION 5.1D Enhance flexibility of range use plans and communicate options and opportunities to producers

- Improving clarity about existing range use planning requirements (and providing information back to producers)
- Undertaking consultation with producers on desired management strategies and range use plans (e.g., use of targeted grazing on Crown land, timing around turn-outs and round-ups, use of prescribed burns)
- Communicating findings to regulatory agencies – particularly priority management strategies that enhance flexibility and adaptability
- Convening sector organizations and regulatory agencies to put forward any recommended changes to enhance flexibility of range use plans

IMPACT AREA 5 > STRATEGY 5.2
Collaborative management of changing wildlife impacts

AS NOTED ABOVE, shifts in the distribution and prevalence of wildlife populations are associated with a number of climate impacts. The affects of wildlife on agricultural operations is an issue of on-going concern for producers in the region, and the sector will be required to anticipate, plan for and/or adjust to changing wildlife populations and interactions.

Many producers have good information on wildlife numbers, wildlife behavior and indicators of impacts, which may not be appropriately incorporated into wildlife management at the provincial level. This information could be formalized and combined with the observations and records of other individuals on the land base in a collaborative tracking and monitoring program.

Looking forward, wildlife management efforts in the region have the potential to be more collaborative. Building on the efforts of the Regional Agriculture and Wildlife Committee (RAWC), which brings together government agencies, First Nations and agricultural organizations, locally developed approaches can be rooted in mutually beneficial solutions including improving coordination with hunters and trappers. Individual producer best management practices (e.g., BC Cattlemen's Wild Predator Loss Prevention Best Management Practices for Cattle) are also likely to be needed, in combination with collaborative actions outlined in this Strategy.

ACTION 5.2A Enhance collaboration with key partners to implement management strategies	ACTION 5.2B Improve collaborative mechanisms for tracking and monitoring changes in the wildlife/agriculture interface	ACTION 5.2C Pilot farm-level approaches to reduce losses from wildlife to feed and livestock
<ul style="list-style-type: none"> ▪ Utilizing the Cariboo-Chilcotin Wildlife Mitigation Regional Strategic Plan, reconvene key partners to identify roles and resources for implementing priority actions ▪ Identifying pilot management strategies, seeking volunteer producer cooperators and partners to pilot in specific geographic locations ▪ Maintaining a collaborative body to continue to respond to changes in populations or management needs 	<ul style="list-style-type: none"> ▪ Convening critical partners to: <ul style="list-style-type: none"> - Determine monitoring priorities and where to allocate resources (e.g., which species, which locations) - Determine the most cost-effective local monitoring strategies (e.g., radio collaring, surveys, anecdotal information) - Identify and seek out funding for collaborative monitoring ▪ Identifying and piloting approaches for effective and easy inclusion of producer data regarding wildlife encounters, and damage (e.g., regional on-line or app-based tracking for wildlife encounters/damage) ▪ Engaging volunteers within non-ranching communities 	<ul style="list-style-type: none"> ▪ Researching possible on-farm strategies and identifying those with the most promise and application to local context ▪ Identifying interested producers to pilot potential management strategies including monitoring and cost-benefit analysis; possible approaches include: <ul style="list-style-type: none"> - Use of trap crops - Diversionary feeding in winter - Stack yard fencing - Ecosystem restoration - Prescribed burning - 3D fencing

Implementation & Monitoring

While all of the actions contained in this plan are important for the Cariboo agriculture sector to adapt to climate change, the actions on the following pages are identified as “next steps.” This is not only due to their importance, but also because they are either relatively easy to implement and/or they will build capacity for further adaptation actions (see text box on this page). Building momentum and capacity for collective action, and addressing the most important issues, will help to ensure implementation of all of the identified actions.

A meeting was held with a number of key partners to prioritize actions and determine how to move forward with them. Specific projects were considered and developed. The input received in this meeting forms the bulk of the content below.

In some cases, individual actions have been merged into single projects because this is the most effective and efficient way to accomplish them. Implementation considerations, such as potential partners and cost range are identified for each of the next steps identified.

The Advisory Committee that supported the development of this plan will transition into a local working group to oversee implementation and monitor progress. This group will continue to include agricultural organizations, local government and provincial government representatives. The Climate Action Initiative will function as the overall coordinator for this group and will also support

project development and assist with monitoring progress and reporting.

For each Action in the Next Steps, potential partners are identified. Potential partners were identified through workshops and subsequent draft development, but no formal commitments have been made regarding roles in various strategies and actions. Continued development of partnerships is an important element of Next Steps.

- *Important* actions are those that address the highest priority impacts or critical gaps for building resilience.
- *Ease of implementation* refers to actions that can be initiated without delay because there is a “window of opportunity,” there are clear co-benefits with other actors or programs, or there are minimal barriers to address. These actions, sometimes referred to as “low hanging fruit,” can also create momentum to help to move more difficult or longer term actions forward.
- *Capacity building* actions support the sector by strengthening the ability of producers and producer organizations to take effective action. This may take the form of filling gaps in knowledge or resources or strengthening the ability to act collectively or individually.

NEXT STEPS FOR ACTIONS 1.1A, 1.2A & 1.2B

Actions

- Develop collaborative agriculture wildfire plans
- Develop agriculture specific wildfire preparedness and mitigation resources
- Develop individual farm/ranch level wildfire plans

Implementation details

- The three actions will be most effectively implemented if merged into a single project and managed collectively
- The agriculture-specific resources should result from piloted planning processes with producers (not just modeling on information from elsewhere)
- Individual plans could also be the first step toward collaborative planning; inventorying resources, gathering information and identifying participants

Potential partners

- Cattlemen's Associations
- Producers
- FLNRO: Wildfire Management Branch
- Cariboo Regional District Emergency and Protective Services
- FARSHA (Farm and Ranch Safety and Health Association)
- BC Ministry of Agriculture
- Emergency Management BC
- First Nations Emergency Services Society of BC

Timeframe

- Short-term (less than 2 years)

Cost

- Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTIONS 2.1A & 2.1B

Actions

- Establish local watershed restoration projects to evaluate and demonstrate restoration and enhancement options
- Evaluate, demonstrate and share soil management and cropping options for improved water retention

Implementation details

- Undertake outreach to key partners involved in similar research in the region
- Identify options for extending existing activity including:
 - University of Northern BC: already doing similar projects via graduate students / university researcher
 - Thompson Rivers University: building on soil carbon research
 - Cariboo-Chilcotin Beetle Action Coalition: Building on lessons learned from pilot in Big Creek and identifying opportunities to expand/enhance

Potential partners

- Agricultural organizations
- Producers
- University of Northern BC
- Thompson Rivers University
- Conservation/watershed groups
- Local governments
- Cariboo-Chilcotin Beetle Action Coalition
- First Nations

Timeframe

- Mid-term (2-4 years)

Cost

- Scope dependent
Medium (\$50,000-\$100,000) to High (\$100,000+)

NEXT STEPS FOR ACTIONS 2.2A & 2.2B

Actions

- Inventory and prioritize existing dams/water storage
- Develop cooperative approaches to dam assessments, upgrades, maintenance and management

Implementation details

- Inventory process is the first step
- Simultaneously communicate with government about need to halt decommissioning of dams
- Undertake initial exploration of collaborative opportunities
- Proceed with 2.2B based on results of previous steps

Potential partners

- Cattlemen's Associations
- Ducks Unlimited
- Ministry of Environment
- Ministry of Agriculture
- Cariboo-Chilcotin Beetle Action Coalition
- FLNRO
- First Nations

Timeframe

- Short-term (less than 2 years)

Cost

- Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTION 3.1A

Action

- Strengthen the capacity for a coordinated regional approach to agricultural research

Implementation details

- The first priority is development of a sustainable (business) model for pan-regional group to develop priorities and link resources – needs to be long-term and sustainable
- Bring groups together and identify potential roles/contributions
- When model is established, compiling and housing historical research, as well as prioritizing and supporting new research would follow as next steps

Potential partners

- Local/regional agricultural associations
- Thompson Rivers University
- University of Northern BC
- Cariboo-Chilcotin Beetle Action Coalition
- Ministry of Agriculture

Timeframe

- Short-term (less than 2 years)

Cost

- Business plan – Low (less than \$50,000)
- Long-term approach to coordination – High (\$100,000+)

NEXT STEPS FOR ACTION 3.2A

Action

- Monitor and evaluate how different grazing and management regimes affect: soils development, nutrient cycling and profitability

→ see ACTION 5.1A for next steps)

NEXT STEPS FOR ACTION 4.2B

Action

- Conduct pilot projects for effective farm-level management (particularly for emerging issues)

Implementation details

- First pilot should expand and extend "Cows Eat Weeds":
 - Identify producers interested in participating
 - Extend reach and document results to share
 - Dissemination and extension support possible via CCCIPC
- Additional pilots could follow -build on existing initiatives such as silvopasture trial and work at Potato House (organic pest management)

Potential partners

- Agricultural organizations
- Producers
- Cariboo Regional District (Invasive Plants Program)
- CCCIPC
- Invasive Species Council
- Ministry of Agriculture
- FLNRO

Timeframe

- Short-term for first pilot (less than 2 years)
- Medium-term for multiple pilots (2-4 years)

Cost

- First pilot – Low (less than \$50,000)
- Multiple pilots – Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTION 4.2C

Action

- Collaborate with key agencies and partners for management of pests, diseases and invasive plants

Implementation details

- First step is to bring people together to identify priority management issues and common issues (define focus, gaps, collaborative opportunities)
- Need to expand materials beyond invasive plants (to other pests, diseases, invasive species)
- Undertake collaborative pilot in visible/ high use areas with range of partners

Potential partners

- Agricultural organizations
- Cariboo Regional District (Invasive Plants Program)
- CCCIPC
- Invasive Species Council
- Ministry of Agriculture
- FLNRO
- First Nations

Timeframe

- Short-term for first pilot (less than 2 years)
- Medium-term for multiple pilots (2-4 years)

Cost

- First pilot – Low (less than \$50,000)
- Multiple pilots – Medium (\$50,000-\$100,000)

NEXT STEPS FOR ACTION 5.1A

Action

- Research, pilot and demonstrate practices and technologies for maintaining range productivity

Implementation details

- Review pilots and demonstrations already conducted/underway and look for opportunities to build out or add on
- Pilot, demonstrate and monitor a silvopasture, ecosystem restoration and/or fuel reduction project combined with more intensively managed grazing
- Bring universities into the process to assist with project design for the pilot
- Specify monitoring requirements/provide training for local data collection
- Incorporate field days into the project

Potential partners

- Cattlemen's Associations
- Producers
- Thompson Rivers University
- University of Northern BC
- Ministry of Agriculture
- FLNRO – range branch (forest stewardship or silviculture), district range staff

Timeframe

- Short-term (less than 2 years)

Cost

- Low (less than \$50,000)

NEXT STEPS FOR ACTION 5.1B

Action

- Pilot alternate livestock watering options

Implementation details

- Identify potential options, applied locally and in other areas such as alternative technologies (solar, small scale horizontal drilling for spring development), reduced evaporation catchment/storage (closed tank) developments
- Focus on options suitable for local conditions (and high impact areas)
- Pilot and demonstrate the identified alternatives

Potential partners

- Cattlemen's Associations
- Producers
- FLNRO – range branch (range practices group), district range staff
- Private industry
- Ministry of Agriculture

Timeframe

- Short-term (less than 2 years)

Cost

- Low (less than \$50,000)
to Medium (\$50,000-\$100,000)

APPENDIX A

Weather, Climate & Variability

WEATHER IS WHAT happens on a particular day at a particular location. Farmers are continually required to adapt to weather conditions to effectively plan and manage their businesses. In contrast, climate refers to long-term trends, patterns and averages over time. These are more difficult to notice through day-to-day or year-to-year experiences, or short-term records of weather. However, over a period of decades, recorded observations can characterize the climate and identify changes.

Anyone who pays close attention to weather forecasts appreciates that predictions of weather are often limited in their accuracy. This is partly because of the many factors that impact weather. Turning to longer, climate-related timescales, in BC we are familiar with the 3–7 year cycles of El Niño and La Niña (“ENSO”), which dramatically impact the climate of individual seasons and years (see Figure 4). Compared to La Niña years, conditions in BC during El Niño years are typically warmer and drier in winter and spring, and less stormy in southern BC.

Adding to the complexity, the Pacific Decadal Oscillation (PDO) is a known pattern that shifts over longer time periods (20 to 30 years) and this is associated with different temperature and precipitation conditions here in BC. It also has a warm and cool phase, and so it can either enhance or dampen the impacts of El Niño and La Niña conditions in a given year.

Figure 4 shows the difference between climate variability, oscillations, and climate change. The many factors that impact the weather create significant variation in what we experience from year to year. However, we are still able to chart averages over long periods of time.

For additional resources see *BC Agriculture Climate Change Adaptation Risk and Opportunity Assessment Series* (www.bcagclimateaction.ca/adapt/risk-opportunity) and *Regional Agricultural Adaptation Strategies Technical Report* (www.bcagclimateaction.ca/adapt/regional-strategies).

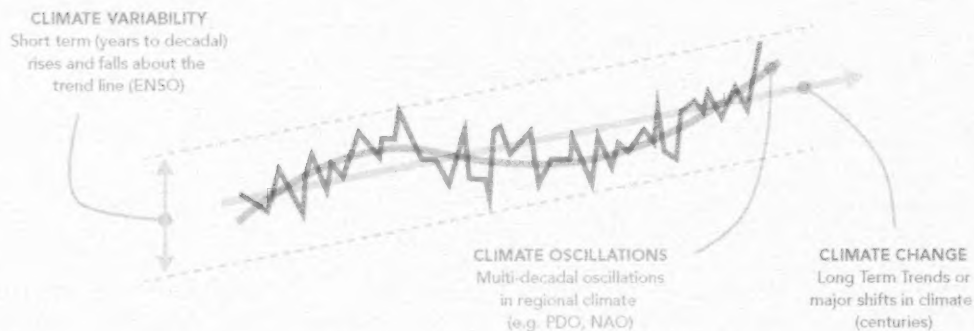


FIGURE 4 Climate Variability, Oscillations & Change

Diagram showing difference between climate variability, oscillations, and climate change.

Adapted from original, courtesy of Pacific Climate Impacts Consortium, www.pacificclimate.org

APPENDIX B

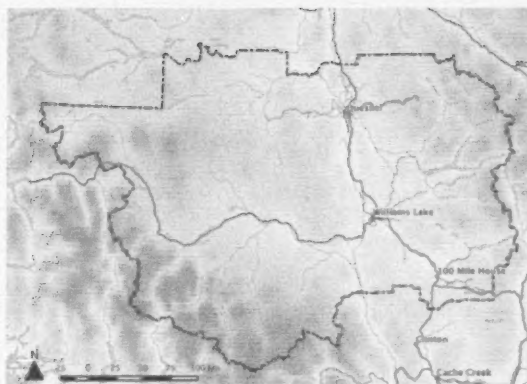
Future Projections: Climate Maps & PCIC Tables

TABLE 2 Cariboo Regional District Climate Projections — 2020s

Climate Variable	Time of Year	Projected Change from 1961-1990 Baseline to 2020s			
		Cariboo (Range)		Cariboo (Average)	BC (Average)
Mean Temperature (°C)	Annual	+0.4 °C	to +1.5 °C	+1.0 °C	+1.0 °C
Precipitation (%)	Annual	2%	to +7%	+4%	+4%
	Summer	9%	to +8%	-3%	0%
	Winter	0%	to +8%	+4%	+4%
Snowfall (%)	Winter	-13%	to +3%	-2%	-2%
	Spring	-60%	to +1%	-30%	-30%
Growing Degree Days (degree days)	Annual	+69	to +230	+147	+153
Heating Degree Days (degree days)	Annual	-540	to -161	-344	-354
Frost-Free Days (days)	Annual	+6	to +22	+12	+10

TABLE 3 Cariboo Regional District Climate Projections — 2050s

Climate Variable	Time of Year	Projected Change from 1961-1990 Baseline to 2050s			
		Cariboo (Range)		Cariboo (Average)	BC (Average)
Mean Temperature (°C)	Annual	+1.1 °C	to +2.6 °C	+1.8 °C	+1.8 °C
Precipitation (%)	Annual	0%	to +13%	+6%	+6%
	Summer	-15%	to +4%	-7%	-1%
	Winter	-3%	to +14%	+7%	+8%
Snowfall (%)	Winter	-15%	to -3%	+9%	-10%
	Spring	-74%	to -12%	-55%	-58%
Growing Degree Days (degree days)	Annual	+160	to +435	+280	+283
Heating Degree Days (degree days)	Annual	-927	to -400	-630	-648
Frost-Free Days (days)	Annual	+14	to +34	+23	+20



Baseline: 1961-1990



Projection: 2050s

Legend

CRD Boundary

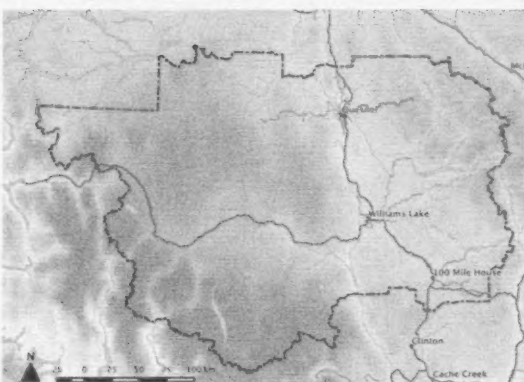
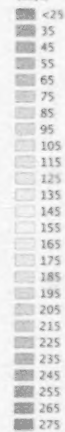
Growing Degree-Days
(Degree-Days)



Legend

CRD Boundary

Frost-Free Period
(days)



Baseline: 1961-1990



Projection: 2050s

FIGURE 6 Frost-Free Period, Baseline and 2050s



Winter, Baseline: 1961-1990



Winter, Projections: 2050s

Legend

CRD Boundary

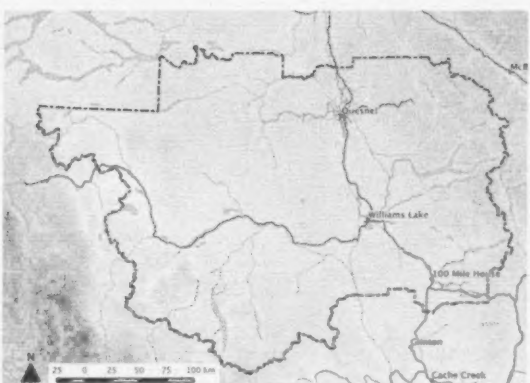
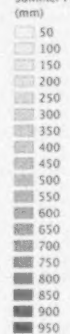
Winter Precipitation (mm)



Legend

CRD Boundary

Summer Precipitation (mm)



Summer, Baseline: 1961-1990



Summer, Projections: 2050s

FIGURE 7 Seasonal Precipitation, Baseline and 2050s

Note that for legibility, winter and summer use different legends and so cannot be directly compared.³⁶

APPENDIX C

Definitions

- *Growing Degree-Days (GDD)*
are a measure of heat accumulation, and represent the cumulative number of degrees that the average daily temperature is above a base temperature of 5 degrees, for all days of the year.
- *Frost Free Days (FFD)*
are the number of days the temperature is above freezing.
- *Frost Free Period (FFP)*
is the consecutive number of days between first frost in fall and last frost in spring.
- *Heating Degree-Days*
are a measure of energy demand, and represent the cumulative number of degrees that the average daily temperature is below a base temperature of 18 degrees (when heating is required), for all days of the year.
- *Cooling Degree-Days*
represent the cumulative number of degrees above a base temperature of 18 degrees (when cooling is required), and is the opposite of Heating Degree-Days.

APPENDIX D

Adaptive Management of Climate Change Impacts

CLIMATE CHANGE ADAPTATION decision-making is an inherently complex task that requires ongoing learning and reflection to adjust to changing information, events and conditions. As learning progresses, new solutions as well as new challenges will be identified. The following questions are provided as tools for navigating this evolving landscape and determining priorities for action.

Additional considerations when determining how to implement priority actions would include:

- Barriers (e.g., legislation, lack of working relationships)
- Assets/Enablers (e.g., leadership, integrating into existing plans/programs)
- Implementation costs
- Operation and maintenance costs
- Financing and resources
- Timeframe

TABLE 4 Developing & Prioritizing Adaptation Actions

Effectiveness	To what degree does this action reduce risk/vulnerability, and/or enhance resilience?
Adaptability	Can this action (and resources dedicated to it) be changed or redirected as conditions change?
Urgency	When does action need to be taken on this issue, in order to be effective by the time an impact is projected to occur?
Gaps & Assets	How does this action address identified gaps or barriers? How can it build on existing assets and resources?
Co-benefits ("no-regrets")	What other benefits would this action have, even if climate change impacts do not occur as projected?
Consequences	What could be the unintended and/or undesirable effects of taking this action? Can these be avoided or mitigated?
Extent	Do the benefits apply broadly in the region, or to specific individuals?
Relevance	Does this action have the support of the agricultural community?

Endnotes

- 1 The Regional Adaptation Enhancement Fund is part of the Ministry of Agriculture's Growing Forward 2 funding programming. Once regional adaptation plans are completed, local partners (working collaboratively with the Program Manager) are eligible to receive up to \$250,000 in implementation funding to deliver projects (over 2–3 years).
- 2 Cariboo Regional District Website. <http://www.cariboord.bc.ca>
- 3 BC Regional Adaptation Collaborative: Cariboo Regional District Case Study. http://www.fraserbasin.bc.ca/Library/CCAQ_BCRAC/bcrac_fbc_cs_crd.pdf
- 4 Crawford, Erica and Emily MacNair. March 2012. *Cattle Production/Central Interior Snapshot Report: BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment Series*. BC Agriculture & Food Climate Action Initiative. <http://www.bcagclimateaction.ca>
- 5 British Columbia Agriculture in the Classroom Foundation. 2008. *Grow BC: A guide to BC's Agriculture resources*.
- 6 Crawford, Erica and Emily MacNair. March 2012. *Cattle Production/Central Interior Snapshot Report: BC Agriculture Climate Change Adaptation Risk & Opportunity Assessment Series*. BC Agriculture & Food Climate Action Initiative. <http://www.bcagclimateaction.ca>
- 7 Ministry of Environment. *Develop With Care: Section 5.1 Cariboo Region*. March 2012. <http://www.env.gov.bc.ca/wld/documents/bmp/devwithcare2012/DWC-Section-5-1-Cariboo-Region.pdf>
- 8 Statistics Canada, 2011 *Census of Agriculture, Farm and Farm Operator Data*, catalogue no. 95-640-XWE.
- 9 BC Regional Adaptation Collaborative: Cariboo Regional District Case Study. http://www.fraserbasin.bc.ca/Library/CCAQ_BCRAC/bcrac_fbc_cs_crd.pdf
- 10 Cariboo-Chilcotin Beetle Action Coalition. <http://c-chac.com/>
- 11 Williams Lake Official Community Plan. *Creating our future — Local Food and Agriculture*. http://www.williamslake.ca/files/1/doc_OCP_Final_Chapter_4_PAto_Local_Food_Agriculture.pdf
- 12 ALR Mapping, Cariboo Regional District. <http://www.alc.gov.bc.ca/mapping/RD/Cariboo.htm>
- 13 Ministry of Agriculture. *Cariboo Regional District Agriculture in Brief Fact Sheet*. 2013.
- 14 Ministry of Agriculture. *Cariboo Regional District Agriculture in Brief Fact Sheet*. 2013.
- 15 Statistics Canada, 2011 *Census of Agriculture, Farm & Farm Operator Data*, catalogue no. 95-640-XWB; and Dobb, Allen 2013. *Forage Production & Export Potential in BC's Central Interior*. Report prepared for the BC Forage Council.
- 16 Ministry of Agriculture. *Cariboo Regional District Agriculture in Brief Fact Sheet*. 2013.
- 17 British Columbia Agriculture in the Classroom Foundation. 2008. *Grow BC: A guide to BC's Agriculture resources*.
- 18 Agriculture and Horticulture Leap is a community event for adults and youth to gain information and support from professionals, companies and institutions regarding opportunities for business, community and education and training related to the agriculture and horticulture economy.
- 19 Zirnhelt, D. 2009. *Agriculture Enterprise Development Centre Feasibility Study South Cariboo and Surrounding Region: A Place for the 100 Mile Diet and Beyond*. Stonefield Consulting.
- 20 Cariboo Regional District Agricultural Policy, 2011.
- 21 <http://www.pacificclimate.org>
- 22 For more explanation of model outputs and ranges, see <http://www.plan2adapt.ca>
- 23 Source for extremes projections: Regional Climate model projections from the North American Regional Climate Change Assessment Program, analyzed by PCIC.

- 24 In accordance with the British Columbia Emergency Response Management System (BCERMS) goals, the priorities of the Wildfire Management Branch in descending order are: human life and safety, property, high environmental and cultural values, and lastly, resource values. Much of agriculture falls into this latter category.
- 25 <http://www.cnl-director.com/reports/CWPPFINAL.pdf>
- 26 Province of BC. Downloaded from the Land Resource Data Warehouse: January 31, 2013.
- 27 Including the San Jose Watershed Regional Adaptation Collaborative <http://racwilliamslake.wordpress.com/the-sane-jose-watershed/> which explored the implications of climate change on forests and forest resources in the watershed and the Fraser Basin Council's workshop (as part of the "Rethinking of Our Water Ways" series) in 100 Mile House http://www.fraserbasin.bc.ca/Library/Water/workshops_summary_rethinking_water_2011-2012.pdf
- 28 http://www.env.gov.bc.ca/wsd/public_safety/dam_safety/
- 29 The Irrigation Industry Association of BC's (IIAB) website <http://www.irrigationbc.com> provides irrigation guides and manuals and the IIAB also offers irrigation courses. The Irrigation Scheduling Calculator is also available on the website. Other resources can be found at Waterbucket <http://www.waterbucket.ca> and Farm West <http://www.farmwest.com>.
- 30 The Cariboo-Chilcotin Forage Variety trials (2009–2012) were led by the BC Forage Association to evaluate forage performance at different elevations, with and without irrigation: <http://www.farmwest.com/sites/default/files/images/ads/Report%202012%20Cariboo%20FINAL.pdf> A silvopasture trial was established at Zirnhelt Ranch to determine the integrated forage and timber production potential, soil moisture response and the economic cost-benefit of an agroforestry approach: <http://www.agroforestry.info/2014/01/cariboo-silvopasture-demonstrates.html>
- 31 The Cariboo Chilcotin Coast Invasive Plant Committee is a non-profit group that works in cooperation with organizations, First Nations, governments and industry to minimize the negative impacts caused by invasive plants through heightened awareness and improved coordination. <http://www.cccipc.ca/>
- 32 The Cows Eat Weeds approach evolved in the United States (Kathy Voth) and involves training cattle to eat weeds/invasive plants: <http://www.livestockforlandscapes.com/cowmanagers.htm> The approach was piloted in the Cariboo and there is interest in expanding it more broadly.
- 33 Gayton, Don. 2013. British Columbia's grassland resources and climate change. *Journal of Ecosystems and Management* 14(2):1–16. Published by FORR^{EX} Forum for Research and Extension in Natural Resources. <http://jem.forrex.org/index.php/jem/article/viewFile/135/495>
- 34 The Cariboo-Chilcotin Regional Agriculture-Wildlife Committee was formed to explore the economic impact of wildlife on agriculture in the region and propose a strategy to prevent loss of forage, annual crops and livestock. The working group has created a Cariboo-Chilcotin Wildlife Mitigation Regional Strategic Plan: http://www.fraserbasin.bc.ca/ccr_agriculture-wildlife.html This committee meets a few times a year to share information, but does not directly implement projects.
- 35 Gayton, Don. 2013. British Columbia's grassland resources and climate change. *Journal of Ecosystems and Management* 14(2):1–16. Published by FORR^{EX} Forum for Research and Extension in Natural Resources. <http://jem.forrex.org/index.php/jem/article/viewFile/135/495>
- 36 Data from Wang, T., A. Hamann, D. L. Spittlehouse, and T. Q. Murdock, 2012: ClimateWNA—High-Resolution Spatial Climate Data for Western North America. *Journal of Applied Meteorology and Climatology*, 51, 16–29, doi:10.1175/JAMC-D-11-043.1.